

Chapter 6

Water

The chapter describes the existing conditions of the surface water and groundwater resources in the proposed project vicinity and evaluates potential impacts the proposed alternatives may have on water resources. The methodology and analyses are discussed in more detail in Appendix E.

6.1 Existing Conditions

6.1.1 Regional Surface Water

6.1.1.1 Drainage Basins

The Lower and Upper Sites lie within the drainage basins of the Middle and South Forks of the Snoqualmie River. The Lower Site is entirely within the drainage basin of the South Fork. The Upper Site is on the drainage divide between the two basins, with drainages on the north side flowing into the Middle Fork, and drainages on the south side flowing into the South Fork. The confluence of the two forks, which is approximately 5 miles northwest of the Lower Site, forms the Snoqualmie River. The Snoqualmie River is tributary to the Snohomish River, which drains into Puget Sound.

6.1.1.2 Precipitation

The closest regularly monitored National Oceanic and Atmospheric Administration (NOAA) precipitation data station to the site is at Cedar Lake approximately 4 miles south/southwest of the Lower Site. The period of record for this measurement station is 1931 to present. Annual precipitation from 1995 to 2000 ranged from approximately 80 inches in 2000 to 114 inches in 1997. The average annual precipitation at this location is approximately 101 inches over the period of record, which is slightly less than the average annual precipitation over the last 5 years. Based on measurements on Grouse Ridge in 1995, annual precipitation near the site was estimated by Golder Associates (1996) to be approximately 80 percent of that at Cedar Lake, or about 81 inches per year.

6.1.1.3 Surface Water Flow

Surface water flow in the Middle and South Forks of the Snoqualmie River results from direct runoff of precipitation, groundwater discharge into rivers, and runoff from snowmelt. Over the last 5 years, monthly average flow rates in the South Fork near the proposed project site have ranged from 26 cubic feet per second (cfs) in September 1998 to 1,160 cfs in November 1995. Over the last 5 years, monthly average flow

rates in the Middle Fork near the site have ranged from 135 cfs in September 1998 to 4,534 cfs in November 1995. Generally, periods of high flow correlate to periods of high runoff due to precipitation in late fall and winter and snowmelt in late spring. The period of low flow that occurs in summer and early fall is considered baseflow, which is sustained by late season snowmelt and groundwater discharge.

Minimum in-stream flow requirements were established by the Washington State Department of Ecology (Ecology) for the Snohomish/Snoqualmie river basin in 1979. An initial assessment of the basin in 1994 showed that the established low flow requirements were not being met. The initial assessment indicated that, at the gauging station at Snoqualmie Falls, minimum instream flows were not being met an average of 114 days per year between 1979 and 1992 (Pacific Groundwater Group, 1995). The variations in streamflow were interpreted to be primarily a feature of climatic variability. A long-term review of stream flows was not completed to determine if instream streamflows have changed historically.

6.1.1.4 Surface Water Quality and Use

The Snoqualmie River is classified as a Class A water source by Ecology. Class A water quality meets or exceeds the requirements for all or substantially all uses, including water supply; stock watering; fish and shellfish rearing, spawning, and harvesting; wildlife habitat; recreation; and commerce and navigation. The Middle and South Forks of the Snoqualmie River are classified as Class AA water sources by Ecology. Class AA water quality “markedly and uniformly” exceeds the requirements for all or substantially all uses.

Individual sampling locations on the Middle and South Forks of the Snoqualmie River are listed on Ecology’s 303(d) list for water body segments that do not meet applicable water quality standards after implementation of technology-based controls (i.e., septic systems or water treatment). Exceedances of surface water quality criteria per Ecology’s 303(d) list appear to be either infrequent events or of a seasonal nature. These exceedances outside the criterion at sampling points on the Middle and South Forks of the Snoqualmie River include temperature, dissolved oxygen, and pH.

6.1.1.5 Usage per Water Rights

Within a 1-mile radius of the Lower and Upper Sites, there are approximately 37 surface water rights. These rights include 24 certificated rights and 13 water rights claims. Groundwater rights records in the proposed project site vicinity include 6 certificated rights, 29 water rights claims, plus 3 water rights applications or permits, which are not certificated rights.

6.1.2 Site Surface Water

6.1.2.1 Lower Site

The Lower Site is in a glacial outwash plain between the Middle and South Forks of the Snoqualmie River, on the west side of Grouse Ridge. An intermittent stream that drains on the west slope of Grouse Ridge (Figure 6-1) flows into the northeast portion of the Lower Site. The porous nature of the ground surface and reconnaissance observations for this EIS suggest that water from this stream and precipitation infiltrate through underlying sands and gravels, rather than leaving the site as surface water runoff. In addition, with construction of I-90, the natural drainage to the south was blocked by the large embankment on which the highway was constructed. Therefore, there is no significant runoff from the site onto adjacent property.

No other significant surface drainage features were observed during the reconnaissance. However, minor ponding of stormwater was observed in low spots, where fine-grained sediments have accumulated. These low spots were observed in the area of the previous gravel-mining operation in the central portion of the site and in the south-central portion of the site adjacent to I-90.

6.1.2.2 Upper Site

The Upper Site is relatively flat. Much of the northern slope of Grouse Ridge has been cleared of timber in recent years and has a light grass vegetative cover. As with the Lower Site, most of the precipitation falling on the Upper Site infiltrates through permeable sands and gravels. No significant surface drainage features, such as streams or wetlands, were observed during the reconnaissance on the upper and relatively flat portion of the ridge. However, minor ponding of stormwater was observed in low spots, where fine-grained sediments have accumulated. There are no offsite drainage basins that contribute runoff to the Upper Site.

On the northern and southern flanks of Grouse Ridge, small streams originate as springs at elevations of between approximately 1,500 and 1,390 feet above mean sea level (msl) (Figure 6-2). Water from the springs feed streams that discharge into either the South or Middle Fork of the Snoqualmie River.

URS established nine surface water measuring points (weirs) below selected springs or groups of springs in March 2000 (Figure 6-2). Streams were not gauged in drainages where all waters appeared to reinfiltrate or in areas that were inaccessible (i.e., private property outside the lease area boundary) at the time of this study. The majority of the ungauged surface water appears to be on the south side of the Upper Site. Based on URS' field observations during the spring reconnaissance and weir installation, it is estimated that the gauging locations account for over 50 percent of the spring discharge from the

upper portion of Grouse Ridge. Surface water discharge measurements were collected between March 2000 and March 2001 (Table 6-1). The total streamflow from the measured springs ranged from 0.56 cfs in March 2000 to 0.15 cfs in September 2000.

Table 6-1
Spring Discharge Measurements

Spring	Spring/Drainage Discharge (cfs)									North Side Total (cfs)	South Side Total (cfs)
	Middle Fork Snoqualmie (north side)					South Fork Snoqualmie (south side)					
	S-1/S- 2/S-3	S-4	S-6	S-7	S-10	S-11	S-12	S-13	S-14		
Weir	W-1/2/3	W-4	W-6	W-7	W-10	W-11	W-12	W-13	W-14		
Date											
03/02-03/2000	0.06	0.15	0.03	0.04	NA	0.09	0.06	0.05	0.09	NA	0.29
3/6/00	0.05	0.14	0.02	0.03	0.07	0.07	0.05	0.04	0.07	0.32	0.24
3/13/00	0.04	0.12	0.02	0.02	0.07	0.05	0.05	0.04	0.07	0.27	0.21
3/21/00	0.06	0.13	0.02	0.03	0.07	0.06	0.05	0.04	0.08	0.32	0.22
4/7/00	0.06	0.14	0.02	0.03	0.07	0.06	0.05	0.04	0.07	0.33	0.21
4/26/00	0.05	0.12	0.02	0.03	0.08	0.05	0.04	0.04	0.08	0.30	0.21
5/26/00	0.04	0.12	0.04	0.06	0.05	0.06	0.04	0.04	0.07	0.32	0.21
06/27-28/00	0.05	0.11	0.01	0.02	0.04	0.03	0.04	0.03	0.06	0.23	0.15
7/27/00	0.03	0.07	0.01	0.01	0.03	0.02	0.03	0.02	0.06	0.15	0.13
8/30/00	0.02	0.04	0.01	0.02	0.02	0.01	0.03	0.02	0.05	0.11	0.11
9/28/00	0.02	0.02	0.00	0.01	0.02	0.00	0.02	0.01	0.05	0.06	0.09
10/28/00	0.01	0.01	0.01	0.02	0.02	0.01	0.03	0.01	0.05	0.07	0.10
11/30/00	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.04	0.07	0.09
12/28/00	0.04	0.04	0.02	0.01	0.01	0.00	0.02	0.01	0.04	0.12	0.08
1/31/01	0.03	0.04	0.01	0.01	0.04	0.01	0.02	0.01	0.05	0.12	0.09
2/28/01	0.04	0.04	0	0.01	0.05	0	0.03	0.01	0.04	0.14	0.08

Elevations in feet above mean sea level (ft msl), cfs = cubic feet per second (1 cfs = approximately 449 gallons per minute)

Discharge (volume of water) measurements were collected at various drainage crossings below the springs and above the Middle Fork in May 2000 and February 2001 to assess whether the stream reaches were gaining or losing water, and to assess the relative proportion of flow that the springs contribute to the streams. The measurements were collected during dry periods so that stormwater runoff would not affect the measurements. Stream flow measured at two crossings downhill of Springs S-1 through S-4, which share a drainage, appeared to remain consistent, and gaining or losing reaches were not identified. A gauging point below Springs S-6 and S-7, which share a drainage, indicated that the stream was gaining significant discharge at elevations below the springs. The increase in flow along this drainage appears to be in part due to surface water that originates from the vicinity of the Washington State Patrol Fire Training Center and Mailbox Peak. Discharge from Spring S-10 reinfiltreated before reaching the first road crossing. Based

on a discharge measurement collected at a stream crossing below the north side drainage at Lake Dorothy Road, discharge from the seven springs on the north side of the Upper Site accounts for an estimated 10 percent of the surface water discharge from the drainage basin on the north side of the ridge.

6.1.3 Regional Groundwater

6.1.3.1 Groundwater Occurrence

Groundwater in the region occurs in a series of interconnected aquifers that are comprised of glacial fluvial materials and bedrock. Golder Associates (1998) has divided these aquifers into shallow unconfined aquifers and deep confined to semi-confined aquifers described below.

Shallow Unconfined Aquifers

Shallow Valley Aquifer. An unconfined aquifer that is located throughout the main portion of the Snoqualmie River Valley from Snoqualmie Falls to the Middle and South Forks of the Snoqualmie River. The aquifer in the site vicinity is up to approximately 100 feet thick and occurs in the alluvium recessional deposits. The aquifer is used primarily for local potable water supply (Golder Associates, 1998).

Upland Aquifers. These limited groundwater occurrences are situated on uplands that commonly flank the valley floor and, in the site vicinity, include the Middle and South Fork Embankments. The aquifers occur in recessional glacial outwash sand and gravels that were deposited in deltas. The embankments are hydraulically linked to the shallow valley aquifer (Golder Associates, 1998).

Deep Confined to Semi-Confined Aquifers

Deep Valley Aquifer. A confined to semi-confined aquifer that is located throughout the main portion of the Snoqualmie River Valley from Snoqualmie Falls to the Middle and South Forks of the Snoqualmie River. The aquifer is tapped by City of Snoqualmie wells and may also be tapped by several wells in the Tanner area. In the study area, the aquifer occurs in the upper coarse-grained soil unit below glacial till. The aquifer is considered highly productive and has been the focus of the investigations conducted by East King County Regional Water Association (EKCRWA). According to Golder Associates (1998), the aquifer is not well defined near North Bend, and there is some uncertainty regarding the continuity of the deep aquifer throughout the valley.

Bedrock Aquifer. Wells in the upper Snoqualmie River Basin obtain groundwater from bedrock reported as sandstone, shale, and basalt (Golder Associates, 1998).

Infiltrating precipitation is the primary source of water to these aquifers. Groundwater recharge in the upper Snoqualmie River Basin is relatively great because of high annual precipitation and coarse-grained surficial materials. Because of the coarse-grained nature of the soils, large areas have little or no surface runoff even after periods of extended precipitation. The U.S. Geological Survey (USGS) (1995) estimates that 69 percent of the precipitation recharges the underlying aquifers in the areas where coarse soils are present. In addition to recharge from precipitation, streams may recharge the shallow valley aquifer during periods of high flow.

6.1.3.2 Groundwater Flow

Groundwater within the shallow and deep valley aquifers is inferred to follow topography and flow from the margins of the valley toward the Middle and South Forks of the Snoqualmie Rivers, and then northwest toward Snoqualmie Falls. Figure 6-3 shows groundwater elevations for wells screened in the shallow and deep valley aquifers. The available groundwater level data support the inferred groundwater-flow pattern.

Groundwater in the study area discharges as seepage to springs and streams, transpiration by plants, groundwater outflow down valley, and withdrawals from wells. In the study area, groundwater discharges from aquifers into the Middle and South Forks of the Snoqualmie River.

6.1.3.3 Groundwater Quality and Use

Wells identified within a 1-mile radius of the Lower and Upper Sites are shown on Figure 6-1. Thirty-eight wells were identified, including 29 domestic wells, 5 municipal water supply wells, 2 industrial wells, 1 irrigation well, and 1 test well (Table 6-2). Most of the wells appear to be screened in the shallow valley aquifer. The closest well to the Lower Site is the Sallal Water District Well No. 3, which is near the northwest corner of the Lower Site (Figure 6-4). Recent water quality data for the Sallal Well No. 3 indicate that groundwater quality is very good (Pancoast, 1999). The wellhead protection for this well extends onto the Lower Site (Figure 6-4).

Table 6-2
Water Supply Wells Within a 1-Mile Radius of the Site

Well Location ^a	Owner ^b	Use	Approximate Surface Elevation ^c feet above msl	Well Depth feet bgs	Water Level ^d feet bgs	Aquifer Screened ^e
T23N/R08E						
12R	Hamilton, M.	domestic	570	99	57	S
13Q	Everson, T.	domestic	650	300	124	B
13N	Highline School Dist. No. 401	test well	580	199	77	D
13R1	Anderson, G.	domestic	700	63	660	-
13R2	Forrester, S.	domestic	710	237	520	-
14G	Alyea, M.	domestic	528	96	30	S
23A	Riverbend Assoc.	municipal	520	60	22	S
23B	Riverbend Assoc.	municipal	500	62	4	S
24A	Rogers, K.	Industrial	650	207	143	D
24B	Schoenbaum, F.	domestic	630	97	25	S
24H	Wonsley, D.	domestic	610	119	74	S
24K	Douglass, D.	irrigation	600	25	4	S
24R	Shea, D.	domestic	610	60	34	S
25A1	Anderson, B.	domestic	590	26	6	S
25A2	Bogden, M.	domestic	590	45	20	S
25K	Wallsh, S.	domestic	670	109	44.8	B
25R	Meyers, E.	domestic	800	315	199	S
T23N/R09E						
Kasperski	Kasperski	domestic	810	-	-	-
Middle Fork Well Assoc. (20B1)	Middle Fork Well Association (Ferris, B)	domestic multiple	780	272	70	D
Community	Community Well	domestic	800	-	-	-
Valley Camp	Valley Camp	domestic	800	35	26	S
17F	Peck, J.	municipal	730	48	0	S
18A	Anger, R.	domestic	920	180	158	S
18F	Strode, J.	domestic	800	88	57	S
18P	Sallal Water District	municipal	785	255	200	D
19D	Sallal Water District	domestic	700	273	183	D
19N	Cloud, D.	domestic	580	54	4	S
20B2	Roloson, J.	domestic	820	400	48	B
20D	Olson, B.	domestic	800	48	32	S
28C	Dept. of Corrections	Industrial	1600	738	596	U
29A	Saemmer, J.	domestic	1100	40	26.5	S
29J1	Saemmer, J.	domestic	1090	29	9	S
29J2	Barkdale, E	domestic	1120	31	15	S
29N	Castagno, K.	domestic	1100	45	8	S
29Q	Brandalise, J.	domestic	1300	100	28	B
29R	Bianchi, L	domestic	1250	40	9.5	S
30C1	South Fork Water Supply	municipal	600	52	21	S
30C2	Oberlander, J.	domestic	620	33	14	S

(-) indicates no data available or unknown

^a Letters designate ¼ Section based on USGS nomenclature system.

^b Owner identified on water well report. Current owners may be different than those indicated in table.

^c Elevations were estimated from topographic maps.

^d Water level reported on the original well log.

^e Aquifer screened:

S = Shallow Valley Aquifer

D = Deep Valley Aquifer

U = Upland Aquifer

B = Bedrock

The nearest wells considered to be downgradient of the Upper Site are south of Grouse Ridge in the Homestead Valley area (wells 29J to 29R on

Figure 6-1). Several wells are also located north of the ridge near the Middle Fork of the Snoqualmie River. These wells are used for domestic purposes. A number of wells, such as Valley Camp and B. Olsen (Well 20D) are less than 50 feet deep and screened in aquifer materials that are interpreted to be either thin deposits of recessional outwash or alluvium (Figure 6-1). These wells receive recharge from precipitation and surface water infiltration in the vicinity of the well. Deeper wells, such as the Middle Fork Well Association well (20B1) and Roloson (20B2) are up to 400 feet deep and completed in either pre-Vashon (glacier) undifferentiated deposits or bedrock. The aquifers in which the wells are screened receive recharge from groundwater sources farther up the Middle Fork Valley and/or the upland aquifers beneath the Upper Site. Groundwater flow in the Middle Fork Valley is expected to be parallel to the river, in a westerly direction.

In addition to the existing groundwater use, Ecology is currently considering a joint water right application filed by EKCRWA and the Seattle Water Department (now Seattle Public Utilities) on January 19, 1994, to withdraw 60 million gallons per day (mgd) (41,600 gallons per minute [gpm]) from the upper Snoqualmie River Basin. If the water right were granted, the water would be used to meet the projected water needs for eastern King County. Due to the current backlog of water right applications at Ecology, there is a long, possibly multi-year, waiting period between the application and granting or rejection of a water right application.

6.1.3.4 Site Groundwater

The presence of groundwater beneath the Lower and Upper Sites was evaluated primarily based on data for 22 borings and wells installed by Cadman, Inc. in 1995 and 1998, and 10 wells installed under the supervision of URS in 1999 and 2000. Boring and well locations are shown on Figure 6-5.

6.1.3.5 Lower Site

Groundwater Occurrence

Four regional geohydrologic units have been identified beneath the Lower Site borings and monitoring wells and through geophysical methods. The four units are recessional glacial outwash (Qvr), glacial till (Qvt), the upper coarse-grained unit (Q(A)c), and bedrock.

The shallow recessional material (coarse gravels and sands) and the till (silty sands and gravels) in the central portion of the Lower Site do not appear to contain significant quantities of water; therefore, they are not considered to be aquifers at this location. The shallow valley aquifer does not appear to exist at the Lower Site. Two monitoring wells at the Lower Site (GR98-1 and GR99-1) appear to penetrate the glacial till and are interpreted to be completed in the top of the upper coarse-grained unit, referred to as the deep valley aquifer (Figure 6-6). However, in this

area, the deep valley aquifer does not appear to be confined. Water levels in these two wells fluctuate in response to seasonal precipitation patterns (Figure 6-7). Greater water level fluctuations than measured in the period of record may occur seasonally or during long-term climatic variations.

Water levels in Well GR98-4 (Figure 6-7) are approximately 60 to 75 feet above water levels in wells completed within the lower portion of the Lower Site and appear to be controlled by the slope and elevation of the bedrock surface, which is assumed to slope steeply to the west (Figure 6-6).

Water levels in well GR95-12 do not fluctuate significantly on a seasonal basis (Figure 6-7) and do not appear to be representative of the local water table.

Conceptual Model for Groundwater Flow

Groundwater beneath the Lower Site originates as precipitation that falls on areas upgradient of the site infiltrates and flows beneath the site, and as precipitation that infiltrates onsite (Figure 6-8). The recharge occurs primarily between the late fall and early spring when average monthly precipitation is highest.

Groundwater at the Lower Site generally flows in a westerly direction, according to analysis of water level elevations (Figure 6-4). The water table (the saturated surface of an unconfined aquifer) is steeply sloped (approximately 15 percent) between well GR98-4, on the eastern side of the Lower Site, and wells GR98-1 and GR99-1. This gradient decreases to the west across the deep valley aquifer and away from the bedrock influence, where highly permeable sands and gravels drain the groundwater.

Groundwater Quality and Use

No groundwater production wells have been completed at the Lower Site. However, the northern portion of the Lower Site is within the wellhead protection area for Sallal Well No. 3 (Compass Geographics, Inc., 1998) (Figure 6-4). The southern boundary of the wellhead protection area closely corresponds with the northern limits of the proposed gravel operation on the Lower Site. The Sallal Well No. 3 appears to be screened in the upper portion of the deep valley aquifer and is located approximately 100 feet northwest of the Lower Site. The aquifer beneath the Lower Site appears to be directly connected with the aquifer screened by Sallal Well No. 3. Estimated travel times for groundwater from beneath the Lower Site to reach Sallal Well No. 3 range from less than 6 months near the northwest corner of the site up to about 3 years for groundwater beneath the eastern site boundary. The level of analysis completed to develop the wellhead protection plan was appropriate for its intended purpose; however, due to the uncertainty of the assumptions, it

should be considered an approximation of the actual capture zone (the area from which a well draws water) for the well.

Groundwater samples from onsite monitoring wells have not been collected and analyzed to assess groundwater quality beneath the Lower Site. Based on results of water sample testing for Sallal Well No. 3, groundwater quality beneath the site is expected to be very good.

6.1.3.6 Upper Site

Groundwater Occurrence

The primary hydrogeologic unit identified beneath the Upper Site is recessional outwash (Qvr). The occurrence of groundwater within this unit is controlled primarily by the presence of silty layers that form the base for perched groundwater. (As the water percolates downward through the sand and gravel in response to gravity, it accumulates [perches] on the lower permeability layers of silt and silty sand.) The presence of groundwater is limited in the upper 100 feet of the sand and gravel beneath the Upper Site (Figures 6-9 and 6-10) due to the limited amount of silt. At a depth of approximately 100 to 120 feet (1,500 to 1,550 feet above msl), silty materials were encountered beneath Grouse Ridge. These silt layers (shallow perching layer) were approximately 5 to 40 feet in thickness, and in some areas appeared to be interbedded with up to 10 feet of sandy materials. This layer was not encountered in borings and wells completed on the west end of the ridge or locally along the south side of the ridge. The shallow perching layer supports the first laterally extensive occurrence of perched groundwater beneath the Upper Site. The perched nature of the groundwater is exhibited by the general absence of wet or saturated conditions in sandy material encountered below the fine-grained perching layer. Groundwater was discontinuously perched on this layer. Groundwater occurs beneath the central portion of the ridge on the shallow perching layer throughout the year at elevations ranging from about 1,510 to 1,540 feet above msl (Figure 6-11). Water levels in this perched zone fluctuate in response to seasonal precipitation patterns.

A second, laterally extensive silty perching layer was encountered at approximately 130 to 160 feet below ground surface (bgs) (1,450 to 1,475 above feet msl). Groundwater was discontinuously perched on this layer. This silty zone (deeper perching layer) was approximately 3 to 25 feet in thickness, and was underlain by silty sand to gravelly material. This layer appeared to be more laterally continuous throughout the ridge than the shallow perching layer, although it was not encountered locally along the north edge of the ridge. Five wells are screened in water-bearing materials above the deeper perching layer. Water levels in these perched zones fluctuate in response to seasonal precipitation patterns.

A test well drilled at the Washington State Patrol Fire Training Academy (28C on Figure 6-1) to a depth of 757 feet bgs encountered groundwater in four zones between 60 and 650 feet bgs (Hart Crowser, 2000). The

deepest water-bearing zone, between 650 and 734 feet bgs (approximately 782 to 866 feet above msl), was encountered directly above the bedrock surface.

Conceptual Model for Groundwater Flow

Groundwater beneath the Upper Site originates as precipitation that falls on the ridge and infiltrates through the permeable surficial deposits (Figure 6-12).

Low permeability layers are limited in extent in the upper 100 feet of the deposits beneath the ridge (Figures 6-9 and 6-10). The water that encounters these discontinuous silty layers may perch on these layers either seasonally or throughout the year, depending on the recharge rate and the permeability and extent of the silty layer. Water perched on these silt layers migrates laterally through the sand and gravel overlying the silt, flows to the edge of the layers, and then continues a downward infiltration through the surrounding sand and gravel. A limited amount of water also may infiltrate directly through these relatively low permeability silty layers.

The shallow perching layer is present at an elevation between 1,500 to 1,540 feet above msl, and groundwater perched on this layer appears to be continuous through the central portion of the site based on groundwater elevations (Figure 6-13). Some of the water accumulating at this depth flows laterally to the south side of the ridge and discharges into Spring S-8, which was observed at an elevation of approximately 1,500 feet above msl. The absence of additional springs at this elevation suggests that the remainder of the water infiltrates vertically down, around, or through the shallow perching layer.

The deep perching layer is present between approximately 1,460 to 1,475 feet above msl (Figure 6-14). The deep perching layer appears to correspond to the elevation of the majority of springs on the north and south sides of Grouse Ridge. Water perched on this layer appears to flow to the north and southeast, intercept the face of the ridge, and discharge at these spring locations.

Below the deep perching layer, evidence of groundwater was observed in three borings. However, the occurrence of water appears to be discontinuous, and no laterally extensive aquifers were encountered between elevations of 1,460 to 1,426 feet above msl. Other evidence of groundwater at greater depths beneath Grouse Ridge includes the presence of Spring S-5 at an elevation of 1,388 feet above msl on the south side of the ridge (Figure 6-2).

Groundwater that does not discharge into springs or streams along the flanks of Grouse Ridge would continue to infiltrate downward and may recharge a deeper aquifer beneath the ridge. This aquifer would most likely be underlain by either low permeability deposits such as silt and clay of pre-Vashon deposits or by the bedrock that underlies the ridge and is evident around the western, southern, and eastern margins of

Grouse Ridge. Given the apparent high bedrock located along the western edge of Grouse Ridge and the absence of springs on the western portion of the ridge, water from this deep aquifer would be expected to flow north toward the Middle Fork of the Snoqualmie River and/or south toward the South Fork of the Snoqualmie River. Water that infiltrates to this depth (greater than 500 feet) also could recharge the aquifer within the bedrock.

Groundwater Quality and Use

Groundwater beneath Grouse Ridge is not currently being withdrawn from wells. The quality of the groundwater has not been tested; however, given the nature of the geologic deposit, the high rate of recharge, and the limited land use development of the Upper Site, excellent water quality is expected.

6.1.4 Water Budget

This section describes a generalized water budget for the Lower and Upper Sites, based on the conceptual models described above and the available data regarding groundwater recharge and discharge. A water budget is a calculation of additions or losses to/from the groundwater system on an annual basis. The water budget is a tool to aid in understanding the availability of water and potential impacts on water quantities by development, water use, or other impacts. The purpose of the water budget is to identify and estimate the primary components of water input and loss from the local groundwater system, such as precipitation, evapotranspiration, and recharge. Recharge is considered important because it is the component of the water budget that is most likely to be affected by the gravel operation. The water budgets for the Lower and Upper Sites focus only on areas that would be disturbed as part of the gravel operation. Components of the water budgets are summarized in Table 6-3.

Table 6-3
Annual Water Budget - Lower and Upper Sites

Lower Site (43-Acre Disturbed Area)			Upper Site (260-Acre Disturbed Area)		
Water Sources	Quantity (acre-feet/year)	Percent	Water Sources	Quantity (acre-feet/year)	Percent
Precipitation ^a	362	100	Precipitation ^a	2,190	100
Run-on ^b	0	0	Run-on ^b	0	0
Subtotal	362	100	Subtotal	2,190	100
Water Losses			Water Losses		
Run-off ^b	0	0	Run-off ^b	0	0
Evapotranspiration ^c	112	31	Evapotranspiration ^c	678	31
Infiltration/Recharge ^d	250	69	Infiltration/Recharge ^d	1,512	69
Subtotal	362	100	Subtotal	2,190	100

^a Precipitation estimated as 101 inches per year

^b Based on field observations

^c Assumed to be 31% of precipitation (USGS, 1995)

^d Assumed to be 69% of precipitation (USGS, 1995)

6.1.4.1 Lower Site

The proposed area of disturbance for the Lower Site covers 43.8 acres, or approximately 1.9 million square feet. During the site reconnaissance, one small intermittent stream that enters the Lower Site near the northwest corner of the site was identified. However, the water from this stream generally appears to infiltrate outside the proposed area of disturbance. Therefore, the water from this stream is not considered in the water budget. There is no significant runoff from the site because the soil is very permeable and the water infiltrates easily. In addition, all drainage and runoff from the site generally flows to low points within the former area of gravel mining or to a low point adjacent to the north side of I-90.

Over the 43-acre disturbed area, the average annual quantity of aquifer recharge is estimated to be approximately 250 acre-feet per year, or 11 million cubic feet. On a continuous flow rate basis, the annual rate of recharge to the aquifer beneath the disturbed portion of the Lower Site is estimated to be a minimum of 0.34 cfs. Review of the range of precipitation over the period of record (1931 to 2000) indicated that precipitation over the area of disturbance at the Lower Site could range from about 230 to 500 acre-feet per year. Assuming that 69 percent of the precipitation recharges the aquifer, aquifer recharge at the Lower Site could range from approximately 160 to 350 acre-feet per year. In years of below average precipitation, recharge may decrease below 69 percent because of increased evapotranspiration. Conversely, in years with greater than normal precipitation, recharge may exceed 69 percent because of a decrease in evapotranspiration.

6.1.4.2 Upper Site

The proposed area of disturbance for the Upper Site covers 260 acres, or approximately 11.3 million square feet. There is no evidence of any significant surface water runoff from the area of the proposed gravel operation, and because the site is on a ridge, there is no potential for run-on.

The estimated average rate of recharge to the perched aquifers beneath the disturbed portion of the Upper Site is approximately 3.0 cfs. Some of the groundwater that infiltrates downward through the permeable deposits discharges as springs along the north and south flanks of the ridge between elevations of about 1,500 and 1,390 feet above msl. In March 2000, the average total discharge rate of the measured springs was approximately 0.5 cfs (see Table 6-1). Based on field observations, it is estimated that over 50 percent of the spring discharge related to the continuous shallow and deep perching layers was measured. Therefore, because the estimated average rate of recharge (3.0 cfs) is significantly greater than the measured rate of spring discharge (0.5 cfs), a majority of the total aquifer recharge water appears to infiltrate through and/or around the continuous deep perching layer. Water that infiltrates deeper into the ridge may recharge other perched aquifers and/or deeper

aquifers beneath the ridge. Water from these aquifers may discharge into streams along the flanks of the ridge or into the South and/or Middle Fork of the Snoqualmie River.

6.2 Environmental Impacts

6.2.1 Construction Impacts

Construction-related impacts associated with groundwater and water supply were not identified. Construction activities are considered to be too short in duration to affect groundwater resources. Construction-related impacts for surface water are described below for each alternative.

6.2.1.1 Alternative 1–No Action

No construction-related water resource impacts would be associated with Alternative 1.

6.2.1.2 Alternatives 2, 3, and 4 (Including Limited Lower Site Mining)

Runoff Volume

As the Lower and/or Upper Sites are developed during construction and the natural ground cover removed, stormwater falling on the site would run off at a higher rate. In addition, the exposed ground surface would be more susceptible to erosion and sedimentation. During ground preparation, measures such as hay bales, silt fences, and interceptor ditches would be installed to control sedimentation and erosion related to construction activities

Construction of site access roads and the conveyor (Alternatives 2 and 2A) also would increase runoff from these graded areas, as well as erosion and sedimentation. Erosion and sedimentation would be minimized by incorporating stormwater controls such as roadside drainage ditches and bioswales into the road design and construction.

The impacts of construction activities on runoff volume as a result of Alternatives 2 through 4 would be minimal.

Surface Water Quality

The greatest potential impact on surface water quality during construction would be from sedimentation and erosion, which cause soil particles to become suspended in stormwater that flows over the exposed soil surfaces. During construction, this could occur as a result of excavation and grading activities and vehicular traffic entering and leaving the site.

During construction, hay bales, silt fences, and hydroseeding of erosion-prone slopes would be used to minimize potential sediment loading of surface water. Stormwater runoff from access roads and the conveyor alignment (Alternatives 2 and 2A) would be managed similarly.

Vehicle traffic, including construction equipment, leaving the site could contribute sediment and debris to roadside drainage courses. Measures to address this impact include stabilized construction entrances and washing of vehicles in a washdown area prior to leaving the site.

The natural topography and the proposed drainage plan would contain all runoff on the Upper and Lower Sites. With proper stormwater management controls and procedures, the impacts of construction activities would be considered minimal.

Floodplain

Construction activity is not proposed within or near to the floodplain of the Middle or South Forks of the Snoqualmie River. No impacts on the 100-year flood elevation would be expected.

6.2.2 Operation Impacts

This section evaluates potential impacts to surface water, groundwater, and the water supply for the proposed project. Potential sedimentation and erosion impacts on surface water and groundwater quality are described along with other surface water and groundwater issues.

6.2.2.1 Alternative 1—No Action

No operation impacts on water resources would be associated with Alternative 1.

6.2.2.2 Alternative 2—Proposal: Lower and Upper Sites Mining - Exit 34

Surface Water

Runoff Volume. As the gravel operation is developed and the natural ground cover is removed, stormwater falling on the site may run off at a higher rate in some locations, such as roadways or parking areas around the processing facility and other new impervious surfaces around the facility at the Lower Site. Based on the proposed layout, the new impervious areas would constitute a small percentage of the total site area; therefore, the increase in stormwater runoff would be expected to be minimal. Most precipitation falling on the site would infiltrate through the porous ground surface and would not become runoff.

At the Lower Site, all stormwater drainage would be contained onsite. No direct runoff from the Lower Site into surface water drainages would be expected to occur. Drainage from the proposed access roads would be

collected in roadside ditches, which would flow to the infiltration ponds. Drainage from the Lower Site access road would be collected and routed to the Lower Site stormwater facilities. Drainage measures for the access roads would generally consist of roadside ditches and culverts, as required. These facilities must be designed in accordance with the current *King County Surface Water Design Manual*, and would be adequately sized to pass the 25-year storm event (the largest rainfall expected within a 25-year period of record), with the capacity to convey the 100-year event without overtopping. The proposed plan would not contribute surface water runoff to downstream watercourses.

Surface water flows onto the northwest portion of the Lower Site seasonally from a small, intermittent stream. The quantity of surface water intercepted by the 80-acre basin which contributes water to this stream was calculated by URS using methods developed by King County. The average annual volume of surface water intercepted was estimated to be 1.1 million cubic feet (8.2 million gallons). Should this runoff not infiltrate into the soil in the northern portion of the site, the water would be diverted to the Lower Site's infiltration pond system.

Stormwater from the Lower Site would be collected, conveyed, stored, and discharged via engineered systems. Specific components would conform with the technical requirements of King County. While the actual size and configuration of the onsite infiltration pond system may vary during the Lower Site's development, the system would have the following basic features:

- An inlet structure that controls the point of entry to the engineered stormwater system, dissipates energy, and discourages short-circuiting of the water quality portions of the system.
- A lined water quality pond (wetpond) that provides "dead storage" for the removal and storage of settleable solids.
- An infiltration area or pond that provides sufficient stormwater detention capacity, infiltration area, and groundwater separation to handle runoff from the Lower Site.

The conceptual location and configuration of the system is shown on Figure 2-3. URS independently evaluated the approximate size of the infiltration pond system required using procedures developed by King County.

Based on this analysis, the required storage capacity for the infiltration pond was estimated to be about 464,000 cubic feet. Using a conservative infiltration rate of 295 minutes per inch, this storage volume would be sufficient to handle a 100-year storm event without overflowing. Assuming a maximum depth of 8 feet, the infiltration pond would occupy about 1.3 acres of the Lower Site. The combined water quality/infiltration facility, including access, fences, and other appurtenances, would occupy less than 2 acres of the Lower Site.

Design of the infiltration pond system would need to consider potential surface water runoff from the intermittent stream in the sizing of the system, either requiring expansion of the infiltration pond's footprint or excavation to a deeper elevation. The proposed configuration of the Lower Site facilities would allow either approach.

All excavations on the Upper Site would be contained within a closed depression. No direct runoff from the Upper Site into surface water drainages would be expected to occur. Stormwater collected in active mining areas would be contained within the active segment and allowed to infiltrate to groundwater. The stormwater runoff would be managed by direct infiltration to surface soil and diversion of excess runoff to infiltration ponds. When constructed, these facilities would be maintained for the life of the mine and reclaimed as permanent man-made riparian zones when mining is complete. Drainage at the slope faces would be controlled through the use of interceptor dikes or swales as necessary. Drainage from the conveyor alignment and the access road for the conveyor would drain back to the Lower Site. Drainage from SE Grouse Ridge Road flows through natural drainage features to streams and eventually to the South Fork of the Snoqualmie River.

Throughout the site, constructed drainage courses would be protected from excessive water velocities by the use of check dams. All disturbed areas would be drained to settling ponds, where suspended solids would settle out.

Based on information provided, the Proposal would not effectively increase stormwater runoff to the downstream system. The use of engineered stormwater control structures and implementation of procedures for erosion and sedimentation control would be expected to result in minimal impacts during site operations.

Surface Water Quality. The greatest potential impact to surface water quality under Alternative 2 would be from sedimentation and erosion, which causes soil particles to become suspended in stormwater that flows over exposed soil surfaces. Other potential impacts include contamination of stormwater runoff by accidental chemical or petroleum product spills and are discussed in Chapter 15, Environmental Health.

The Proposal would control sedimentation and erosion problems in several different ways. The onsite stormwater runoff that does not infiltrate directly into the soil would be collected and conveyed to infiltration ponds. Rock or vegetation-lined ditches and swales would be constructed to reduce sediment loading to the onsite infiltration ponds. Hay bales, silt fences, and hydroseeding of erosion-prone slopes would further minimize potential sediment loading of surface water. Stormwater runoff from the access roads would be managed in the same way.

A detailed stormwater drainage plan would be required for this project, and submitted to King County for approval prior to the start of any

construction activity onsite. Because the project site would be developed in several phases, a phased drainage plan would be required.

In addition to the requirements of the drainage plan, the site must also comply with the National Pollution Discharge Elimination System (NPDES) permit issued by Ecology. The NPDES permit and King County's standards mandate that stormwater control facilities be provided to manage the volume of water resulting from the 10-year, 24-hour storm event.

Truck traffic leaving the site with aggregate products could also affect surface water quality. Sediment and debris could end up in roadside drainage courses. Measures to lessen this impact include paving the access roads and washing the vehicles in a contained truck wash facility prior to leaving the site. Wash water would be treated and recycled at the truck wash facility.

The proper implementation of surface water controls, policies, and procedures would result in minimal impacts during site operations.

Floodplain. The Proposal does not include mining within or near the floodplain. No impacts on the 100-year flood elevation are expected from implementation of the Proposal or final reclamation.

Springs and Streams on Grouse Ridge. The potential water quality impacts and changes in flow rates for the springs and streams that originate on Grouse Ridge are described below.

Water Quality—There would be no direct runoff from the Upper Site into the springs and streams on Grouse Ridge because of the proposed bowl-like excavation operation. Interception and filtration of turbid water by the sandy and silty zones occurring within the ridge materials, combined with low groundwater velocities, would be expected to remove turbidity before groundwater is discharged to the springs, provided that the excavation would not extend into perched zones that are in direct hydraulic connection with the springs. Additional analysis of groundwater quality impacts is described below.

Spring and Stream Flow—Aquifer recharge would be expected to increase slightly as a result of the proposed mining operation. The changes would occur gradually across Grouse Ridge over an estimated 25-year period. Springs that receive water from areas where mining is occurring or has recently occurred would be expected to receive greater quantities of water due to the increased recharge.

The travel time for infiltrating water to reach the springs would decrease because of the removal of about 100 feet of sand and gravel from the ridge (Figure 6-12). Water levels in wells screened at the perched water layers would be expected to respond to large precipitation events in a period of days or weeks. Likewise, the removal of soils would decrease the period between seasonal

precipitation and maximum flow to the springs. Precipitation and spring flow data indicate there is a lag time of approximately 2 months between maximum seasonal precipitation and spring discharges. Based on the proposed volume of soil removal, the time lag could be expected to decrease by up to one-half. The expected net result of this would be more rapid response in the spring flow rates to precipitation and wider fluctuations in the average daily or monthly flow rates in the springs and streams. Increased flows from these springs would not be expected to cause additional flooding or erosional concerns or significant changes to turbidity or water quality because the water discharged at the springs represents only a small percentage of the total stream flow along the flanks of Grouse Ridge. For example, only approximately 10 percent of surface water flow off the north side of the Upper Site is derived from spring discharge along the Upper Site. Below the steeper flanks of Grouse Ridge, the majority of the annual spring and surface water discharge is derived from the downslope movement of water throughout the subsurface and subsurface stormflow in the forested ridge side drainages, as well as contribution from Mailbox Peak and drainages adjacent east of the Upper Site. This component of annual discharge would not be affected by the proposed operations.

As the mining and reclamation progresses and changes to the landform increase, the potential exists for the areal distribution of recharge to change significantly. Fine-grained soils are proposed to be placed in areas that are reclaimed, and slopes would be introduced into areas that were previously flat. This combination would tend to increase runoff and could focus recharge in new or different areas. Runoff would be routed to stormwater infiltration ponds which, depending on their location, could change the quantity of water flowing into springs and streams. Ponding may seasonally develop in response to the use of fine-grained soil or in areas where the cut depth encounters the perched water table. Following site reclamation, the quantity of water recharging the perched aquifers could decrease to below pre-mining levels if the use of fine-grained material to reclaim the Upper Site or the excavation depth contributes to significant ponding that would increase evaporation.

Overall, expected impacts to the spring flow under Alternative 2 would be low provided that: (1) the infiltration ponds and other drainage features constructed as part of reclamation are designed to minimize the ponding of water over large areas at the base of the excavation; and (2) the ponds are located with the intent of distributing recharge across the base of the excavation, in a manner similar to existing conditions, rather than focusing it in a few locations.

South and Middle Forks of the Snoqualmie River. Groundwater from beneath the Lower Site may discharge into the Snoqualmie River's Middle and South Forks. Groundwater beneath the Upper Site discharges into small streams that drain into the river forks, and groundwater beneath

the Upper Site may discharge directly into the forks. If the quantity of groundwater beneath the site changes, this could affect the South and Middle Forks.

Lower Site—The use of groundwater as the source of water for the Proposal would decrease the quantity of water in the aquifer beneath the Lower Site. On average, the quantity of groundwater moving beneath the site is not expected to decrease by more than the average rate of water usage for the Proposal (0.16 cfs). Depending on the hydraulic connection between the aquifer that the water would be pumped from and the Middle and South Forks of the Snoqualmie River, there could be a slight decrease over time in the groundwater contribution to the river. In the South Fork and Middle Fork, the average daily stream flows upstream of the site are 300 and 1,230 cfs annually, respectively. The potential decreased contribution of water from the aquifer is considered relatively insignificant with respect to the average flow in the rivers.

Based on water level elevations collected at the Lower Site monitoring wells and historic water level information from Sallal Well No. 3, groundwater gradients were calculated between the Lower Site and the Middle and South Forks of the Snoqualmie River. Based on the calculated gradients, Sallal Well No. 3 transmissivity, and estimated permeability of the aquifer sands, lag time between groundwater interception by a theoretical well at the Lower Site and the rivers is estimated to be between 1,000 days (South Fork) and 2,500 days (Middle Fork). This is the period of time a water molecule would take to travel from the location of the well to a potential discharge point in one of the rivers. However, impacts to streamflow could occur more quickly because pressure changes within the aquifer could be transmitted more rapidly than the water molecules would flow from one point to the other.

Upper Site—The enhanced recharge at the Upper Site would likely increase the quantity of water contributed to the Middle and South Forks of the river. The increase in contribution could result from increases in spring discharge, which increases the flow in tributary streams, or increased groundwater contribution to the rivers. The increases would be very small compared to ranges of flows in the rivers. These slight increases would, however, on an annualized basis, tend to offset the potential small decrease in stream flow that could result from groundwater pumping at the Lower Site.

Groundwater

Buffer Zone. Due to the coarse nature of the soils and lack of fine-grained confining units, gravel mining often occurs in areas where groundwater is considered to be susceptible to surface impacts and in aquifer recharge areas. The Lower Site is located in an area characterized as an aquifer recharge area, and as an area of high susceptibility to surface impacts. Gravel mining can also decrease the

distance between the ground surface and aquifers, or in the cases of a 'wet' mine, occurs within the water table or river floodplain. Wet mining can cause direct impacts of mining on the groundwater and aquifer, such as changes to turbidity and temperature (Thurston County, 1995). These actions can increase the risk to aquifer water quality.

Because of these concerns, the proposed excavation plan includes a buffer zone between the ground surface and the top of the regional aquifer beneath the Lower Site to prevent direct contact of the groundwater surface with the base of the proposed excavation. The buffer zone is the vertical distance between the base of the proposed excavations at the Lower and Upper Sites and the seasonal high groundwater level in the underlying aquifer(s). Cadman, Inc. incorporated a buffer zone into their mining plan at the Lower Site to provide protection of groundwater. The purpose of the buffer zone would be to provide an adequate vertical separation so that if there is a spill of chemicals, lubricants, or fuels onsite, the operator can respond to the spill in accordance with the Spill Prevention and Emergency Response Plan before the underlying groundwater becomes impacted. In addition, during reclamation, the buffer zone would provide separation from the water table needed for the development of roots for trees that would be planted at the site.

Assessment of Buffer Zone Thickness–Lower Site—An evaluation of water-level data for wells at the Lower Site indicates that the buffer zone would be exceeded 20 feet over at least the western 3/4 of the Lower Site following excavation to the proposed base depth, which ranges from approximately 630 to 650 feet above msl (Figure 6-6). In the central portion of the site, where the asphalt and concrete facilities would be located, water-level measurements indicate that the buffer zone would be a minimum of 30 to 40 feet.

In the eastern portion of the Lower Site where the gravel washing, crushing, and sorting would occur, the base elevation of the proposed excavation ranges from 640 to 650 feet above msl. Seasonal high water level elevations in the two wells in this area (GR98-1 and GR99-1) have been measured between 621 to 632 feet above msl (Figure 6-7). Higher groundwater levels would be expected beneath the easternmost portion of the excavation. In this area, the potential exists that the water table could be encountered during excavation if the excavation took place during the period of high seasonal groundwater levels; however, the aquifer would not be breached. The proposed groundwater seepage interception trench should maintain a minimum 5-foot buffer zone beneath the easternmost portion of the Lower Site during ongoing site operations (Figure 6-8) if it were properly designed and maintained.

Assessment of Buffer Zone Thickness–Upper Site—Alternative 2 proposes to remove sand and gravel to an elevation of 1,535 feet above msl, which corresponds to removal of about 100 feet of gravel, or less (Figure 6-9).

Shallow perched groundwater exists beneath the Upper Site. Excavation to an elevation of 1,535 feet above msl would remove shallow and discontinuous perched water-bearing zones within the excavation footprint. These discontinuous perched zones would be excavated, and the water would drain into the excavation and infiltrate and migrate downward to the underlying perched water-bearing zones that appear to be more laterally continuous (Figure 6-12). This could increase water levels in the deeper perched zones and/or result in increased spring discharge. Given the apparent limited extent of these discontinuous perched zones, the relatively small quantity of water contained in the zones, and the lack of evidence that they contribute water directly to the springs on the flanks of the ridge, expected impacts associated with their removal would be minimal.

The more laterally continuous water-bearing zones would not be breached; however, groundwater within the continuous shallow perching zone locally rises above proposed excavation base. Specifically, the water level in well GR95-2 (Figure 6-11) has risen above the proposed base elevation for the Upper Site for a short period of time during 4 of the last 5 years. Based on these measured water levels, there would be no buffer zone with the continuous perched aquifers on a seasonal basis in certain areas of the excavation (Figure 6-12). However, given that the water levels in only 1 of the 11 existing wells on the Upper Site was within 15 feet of the proposed excavation base during the winter and spring of 2000, the extent of the water table interception is expected to be limited and only likely to occur where the shallow perching layer is present.

Groundwater Quality. Groundwater quality at the Lower and Upper Sites has the potential to be affected by surface water infiltration through the excavation pit floor or through the infiltration ponds.

Surface water runoff at the site can infiltrate through permeable surfaces. The primary impact on this water would be turbidity from fine-grained (typically clay to silt-sized) particles. In general, turbidity within groundwater has not been found to be a significant impact where gravel mining does not intercept the groundwater table (Thurston County, 1995). Turbidity is reduced or removed from water through gravitational settling and filtration through sediments. The transport of fines (silts and clays) from stormwater runoff through the infiltration ponds into an aquifer would be limited by the mechanical screening effect of the soils that would make up the bottom and sides of the ponds. Initially, the finer clay particles would be able to move vertically into the aquifer; however, over time the accumulated silts in the base of the ponds would effectively stop the transport of clay particles. Over time the pond infiltration rates would decrease, and the transport of fine particles to the aquifer would also decrease. Fine soil particles may be able to move vertically into the underlying soils due to the relatively high gradient and velocities. The same particles would not be able to effectively move

laterally through the same materials due to the low water velocities (Thurston County, 1995).

At the Lower Site, the intent of the Proposal is to maintain an adequate buffer zone. The potential exists that some turbid water may infiltrate through the buffer zone; however, the silts and clays would settle out in the aquifer in a relatively short distance and would not likely be transported offsite. In portions of the Upper Site, where the buffer zone above perched aquifers may be absent seasonally, turbidity could locally impact groundwater quality immediately below the site when the groundwater table is above the floor of the mine. However, filtration of turbid water by the sandy and silty zones beneath the Upper Site and the low groundwater velocity would be expected to be sufficient to remove turbidity before groundwater is discharged to springs, streams or wells.

Aquifer Recharge. Surface conditions at the Lower and Upper Sites would be modified as part of this alternative, and this modification of surface conditions has the potential to impact groundwater recharge. The change in recharge is dependent on the area that would be disturbed, the improvements that would be constructed, and the rate at which the Lower and Upper Sites would be developed and reclaimed.

Lower Site—Vegetation and topsoil would be stripped from approximately 43 acres of the Lower Site surrounding the processing area. This would increase infiltration rates and aquifer recharge by exposing permeable sands and gravels and would decrease evapotranspiration by removing vegetation. Although recharge in this portion of the disturbed area would increase, the increase is expected to be modest (less than 0.1 cfs) given that: (1) an estimated 69 percent or more of the precipitation (about 0.35 cfs) already recharges the aquifer in the area that would be disturbed by the gravel operation; the range of precipitation over the period of record (1931 to 2000) indicates that precipitation recharging the aquifer at the Lower Site could range from approximately 0.24 to 0.5 cfs; (2) approximately half of the 43-acre area that would be disturbed has been previously used as a gravel mine, which has already enhanced recharge; (3) an estimated 35 percent or more of the disturbed portion of the Lower Site would be revegetated during the early phases of the gravel operation, thereby decreasing the area over which enhanced recharge would occur to about 25 acres.

Surface water runoff at the Lower Site would be routed to a stormwater infiltration pond in the western portion of the excavation, and infiltration would be focused in this area. Depending on the amount of runoff, this could result in the local mounding of groundwater around the infiltration pond. Given the apparent high permeability of the sand and gravel deposits beneath the pond, the mounding is expected to be small.

In areas where the excavation would reduce the ground surface elevation, the vertical distance traveled by infiltrating water before it

encounters the water table would decrease. Aquifer recharge in these areas would reach the water table more rapidly; however, a comparison of monthly precipitation records and hydrographs for monitoring wells (Figure 6-7) shows that recharge is already relatively rapid and this change is considered to have minimal impact with respect to recharge at the Lower Site.

Upper Site—The Upper Site aquifer recharge would be expected to increase due to exposure of permeable sand and gravel and removal of vegetation. If a perched water table seasonally rises above the base of the excavation, this could provide additional opportunity for evaporation, but this would likely occur over a limited area during winter or early spring when evaporation rates are low. In addition, as the depth of the mine increases, the travel time for water infiltrating from the surface to the continuous perched aquifers would decrease.

The Upper Site is proposed to be mined in 50-acre increments, with reclamation and revegetation occurring after operational area needs are met. As part of the gravel operation, precipitation would be intercepted in settling ponds for use in facility processes, which would affect aquifer recharge. The impact on groundwater recharge would be proportional to the area of the pond. This decrease in recharge would be offset, at least in part, by increases in recharge described above.

Overall, the increased rate of recharge is expected to be modest for the following reasons: (1) an estimated 69 percent or more of precipitation (about 3 cfs on average) already recharges the perched aquifer in the area that would be disturbed by the gravel operation; (2) the Upper Site would be developed in phases and would be revegetated as the gravel operation expands across the site and, therefore, only a fraction of the Upper Site would provide enhanced recharge at any time during the lifetime of the project; (3) most of the area was recently disturbed by logging, which enhances recharge by decreasing interception and uptake of water by vegetation; and (4) precipitation would be intercepted by the settling ponds, thus decreasing potential recharge. The increased recharge may locally increase water levels in the continuous perched aquifer zones due to the limited nature of this aquifer system and the relatively low permeability of the silty material below the base of the excavation.

During site operations, stormwater runoff would be expected to infiltrate readily through the exposed sand and gravel deposits, which should minimize the redistribution of water recharging the perched aquifers. Runoff could occur in areas where silty layers are encountered. This runoff could result in recharge occurring in new or different areas.

The use of fine-grained soils to reclaim the Upper Site would affect stormwater runoff patterns. The Draft Reclamation Plan (Dunton, 2000) indicates that all stormwater would be captured and routed to

infiltration ponds. The ponds would be designed to store and infiltrate the stormwater. The use of these ponds has the potential to redistribute the groundwater recharge to the perched aquifers. The recharged groundwater may locally mound in areas beneath these infiltration ponds.

Water Supply Wells. More than 30 domestic and municipal water supply wells have been identified within a 1-mile radius of the proposed project site. Wells most susceptible to water quality impacts are those located potentially downgradient of the Lower Site because the Lower Site is located directly above a regional aquifer. Wells screened in the regional aquifer and located downgradient include Sallal Water District Well No. 3, an industrial well, and several domestic wells. These wells are more than 2,000 feet downgradient of the eastern portion of the proposed excavation, which is the area considered most susceptible to groundwater impacts. Several domestic and community supply wells are present in the Middle and South Fork valleys. These wells are at least 1,500 feet downgradient of the Upper Site and vertically separated from the existing ridgetop by up to 1,000 feet elevation difference. However, because no groundwater withdrawals are proposed at the Upper Site, and aquifer recharge at the site would be increased due to excavation activities, no adverse groundwater quantity impacts would occur in the Middle or South Fork valleys.

Water Supply

The proposed mining operations under Alternative 2 are estimated by Cadman, Inc. to consume approximately 150,000 gallons per day, or 6 percent of the total daily water usage. The gravel operation is expected to operate 250 days per year and would consume an estimated 37.5 million gallons of water annually. This corresponds to a continuous consumptive water usage of about 70 gpm or 0.16 cfs.

The proposed source of the water to be used by the gravel mining operation is groundwater from a well on the Lower Site. A production well at the Lower Site, if completed in the deep valley aquifer, would be expected to have similar hydrogeologic properties to the Sallal Well No. 3 because of the proximity of Sallal Well No. 3 to the Lower Site. Sallal Well No. 3 currently yields about 75 gpm. Prior to use of the water, Ecology approval would be required to obtain a groundwater right.

Consumptive water use would exceed groundwater pumping rates during hours of operation. To meet peak water requirements, water would be stored in an underground vault with an estimated storage capacity of 300,000 gallons. The underground vault would be located beneath the truck parking area in the western portion of the mine pit. The depth to groundwater in the vicinity of the vault (estimated to be 30 feet or more) is greater than the proposed depth of the vault (about 8 feet); therefore, the vault would not intercept the aquifer.

The extraction of groundwater has the potential to decrease water levels in the aquifers in the site vicinity. The average annual pumping rate for the well at the Lower Site is estimated to be 70 gpm. At this rate, there would be a potential for drawdown of an aquifer that could interfere with other wells. If the water supply well was screened in a different aquifer than the wells in the surrounding area, this potential interference could be minimized.

As described above, the rate of enhanced aquifer recharge at the Lower Site is expected to be less than 0.1 cfs, and the average groundwater withdrawal for the proposed project is estimated to be 0.16 cfs. Therefore, on average, there would be a net decrease in the amount of groundwater beneath the Lower Site. In years with below average precipitation, the impacts could be greater, and during years with greater than average precipitation, impacts would be less. This decrease in water beneath the Lower Site could lower the water level in nearby wells and could result in reduced stream flows.

The proposed use of groundwater resources is considered a moderate impact because water resources in the drainage basin are insufficient, under certain conditions, to meet minimum in-stream flow requirements established by Ecology.

6.2.2.3 Alternative 2A–Upper Site Mining and Limited Lower Site Mining - Exit 34

Impacts under Alternative 2A would be the same as under Alternative 2, except where noted below.

Surface Water

The impact on runoff volume under Alternative 2A would be slightly less than Alternative 2 because the disturbed area would be reduced on the Lower Site. Impacts are expected to be minimal.

Aquifer recharge would decrease slightly under Alternative 2A when compared to Alternative 2 due to the decrease in the disturbed area. The potential impact on flow rates in the South and Middle Forks of the Snoqualmie River as a result of this small change is considered negligible when compared to Alternative 2. Potential impacts on water quality would be similar to Alternative 2.

Groundwater

Under Alternative 2A, aquifer recharge would decrease slightly when compared to Alternative 2 due to the decrease in the disturbed area on the Lower Site.

Water Supply

Alternative 2A would require the same amount of water as Alternative 2. Due to the decrease in aquifer recharge, the impacts would increase slightly.

6.2.2.4 Alternative 3–Lower and Upper Sites Mining - Exit 34 and Exit 38

Impacts for Alternative 3 would be the same as for Alternative 2, except where noted below.

Surface Water

Surface Water Quality. Alternative 3 would include improvements to SE Grouse Ridge Road. Drainage from SE Grouse Ridge Road would be drained offsite to the downstream drainage system. Because this is an existing roadway, impacts on drainage resulting from the proposed road improvements are expected to be minimal.

Springs and Streams on Grouse Ridge. Alternative 3 would include a semi-permanent processing area on the Upper Site that would provide another area where enhanced recharge would occur throughout the 25-year project period. This is expected to slightly increase recharge to the continuous shallow perched aquifer in the eastern portion of the Upper Site when compared to Alternative 2. This continuous increased recharge is expected to slightly increase discharge to springs and streams in this area.

South and Middle Forks of the Snoqualmie River. Potential impacts on water quality would be slightly higher under Alternative 3 because springs and streams on Grouse Ridge would be at slightly greater risk from the increased activities on the Upper Site. However, the overall risk to water quality is still considered to be low.

Groundwater

Aquifer Recharge. Alternative 3 would include a processing area on the Upper Site that provides another area where enhanced recharge would occur throughout the 25-year project period. This is expected to slightly increase recharge to the shallow perched aquifer in the eastern portion of the Upper Site when compared to Alternative 2.

6.2.2.5 Alternative 6.2.2.5 Alternative Lower Site Mining - Exits 34 and 38

Impacts under Alternative 3A would be the same as under Alternative 3, except where noted below.

Surface Water

The impact on runoff volume under Alternative 3A would be slightly less than under Alternative 3 because the disturbed area would be less on the Lower Site. Impacts are expected to be minimal.

South and Middle Forks of the Snoqualmie River

Aquifer recharge would decrease slightly under Alternative 3A when compared to Alternative 3 because less area would be disturbed. The potential change to flow rates in the South and Middle Forks of the Snoqualmie River due to this small change is considered negligible when compared to Alternative 3. Potential impacts on water quality are similar to Alternative 3.

Groundwater

Under this alternative, aquifer recharge would be slightly less when compared to Alternative 3 due to the decrease in the disturbed area on the Lower Site.

Water Supply

Alternative 3A would require the same amount of water as Alternative 3, but because of the decrease in aquifer recharge, the impacts would increase slightly.

6.2.2.6 Alternative 4—Upper Site Mining - Exit 38

Impacts under Alternative 4 would be the same as under Alternative 3, except where noted below.

Surface Water

There would be no impacts to surface water at the Lower Site because it would not be mined under Alternative 4.

South and Middle Forks of the Snoqualmie River

Groundwater recharge at the Lower Site would not be enhanced under Alternative 4 because the site would remain undeveloped. Therefore, potential impacts on the rivers due to decreased groundwater contribution could increase slightly because the water supply for the project would be groundwater from the Lower Site. Impacts on groundwater recharge at the Upper Site would be similar to Alternative 3. Overall, the potential impact on flow rates in the South and Middle Forks of the Snoqualmie River are considered negligible when compared to Alternative 3.

Groundwater

Buffer Zone. Under Alternative 4, the impacts on groundwater resulting from the buffer zone would be the same as Alternatives 2 and 3 for the Upper Site because the excavation would extend to the same depth. However, there would be no mining at the Lower Site; therefore, there would be no impacts related to the buffer zone at the Lower Site.

Groundwater Quality. Because the Lower Site would not be mined under Alternative 4, there would be no potential impacts on groundwater quality at the Lower Site.

Aquifer Recharge. There would be no impact on groundwater recharge at the Lower Site because it would not be mined.

Water Supply

Alternative 4 would require approximately 12 percent less water than Alternatives 2 and 3 because water for the concrete batch facility would not be required. The water would be pumped from beneath the Lower Site but would not be offset by enhanced recharge at the Lower Site because it would not be mined. Therefore, there would be a greater impact on the quantity of water flowing beneath the Lower Site.

6.2.3 Cumulative Impacts

6.2.3.1 Alternative 1–No Action

No cumulative impacts to water resources would be associated with Alternative 1.

6.2.3.2 Alternative 2–Proposal: Lower and Upper Sites Mining (Including Limited Lower Site Mining)

The cumulative surface drainage impacts on the surrounding drainage basin resulting from the Proposal are considered minimal. The Proposal would contain nearly all surface runoff, and discharges from the site would generally be to groundwater. Although the project would intercept some stormwater, and thereby prevent it from reaching groundwater, the volume removed would be considered minimal and the net effect to groundwater flow rates should be negligible.

Surface water quality would be monitored over the life of the project in accordance with applicable mining, grading, and discharge permits to ensure that discharge to groundwater is not affected. Because the threat of contamination would be identified at the ground surface (e.g., staining), any contamination would be identified before it could affect the Middle or South Forks of the Snoqualmie River. However, if surface impacts were not identified, the groundwater monitoring program would be designed to sample groundwater at a sufficient interval to identify potential contaminants before they migrated offsite.

Although there are no indications that a significant impact on the Snoqualmie River drainage basin would result from the Proposal, continual monitoring of drainage issues would prevent any unidentified adverse impacts from occurring.

Groundwater withdrawals in the Snoqualmie Valley can be expected to increase as development continues. Future groundwater uses may include residential, commercial, and municipal withdrawals. The extraction of groundwater for the Proposal would contribute to this overall increase in groundwater usage. This would decrease the quantity of groundwater available for other development in the vicinity of the Lower Site. The use of groundwater at the Lower Site would be offset in part by enhanced recharge at the Upper Site; however, this recharge would be in a different location than where the water would be extracted. Although recharge at the Upper Site, like the groundwater beneath the Lower Site, would be expected to ultimately discharge into the Middle and/or South Fork of the Snoqualmie River, the time required for the water to reach the rivers would likely change as a result of the Proposal. The timing of this discharge may be important because groundwater provides baseflow to the streams and rivers in the area during the late summer and fall. The cumulative impact of groundwater withdrawal associated with the Proposal and other withdrawals in the basin could reduce baseflows.

6.2.3.3 Alternative 3—Lower and Upper Sites Mining (Including Limited Lower Site Mining)

Under Alternative 3, the overall disturbed area would be less, and the natural drainage on the west face of Grouse Ridge would not be affected. The remaining cumulative impacts would be similar to Alternative 2.

6.2.3.4 Alternative 4—Upper Site Mining - Exit 38

Under Alternative 4, the overall disturbed area would be less. The Lower Site would remain undisturbed and the existing drainage at the Lower Site and the natural drainage on the west face of Grouse Ridge would not be affected. Cumulative impacts are not expected at the Lower Site. The cumulative Upper Site impacts would be similar to Alternative 3, although no concrete or asphalt plants would be located at the Upper Site.

6.3 Mitigation Measures

6.3.1 Alternative 1—No Action

No impacts to water resources requiring mitigation were identified for Alternative 1.

6.3.2 Alternative 2–Proposal: Lower and Upper Sites Mining (Including Limited Lower Site Mining)

6.3.2.1 Surface Water

The overall goal of surface water protection for the proposed project is to minimize erosion and control sediment transport and deposition. The following actions are proposed to mitigate potential impacts:

- Temporary erosion and sediment controls should be inspected on a daily basis and continually adjusted to match current site conditions and operations.
- Permanent erosion and sediment controls should be inspected and maintained on a routine, scheduled basis in accordance with established operating policies and procedures.
- Permanent drainage features and controls should be constructed as each phase of development occurs and should be maintained throughout the period of operation.
- Completed phases of gravel extraction and grading should be restored and revegetated in a timely manner.
- Long-term monitoring of surface water quality should be implemented during construction, operation, and post-closure of the proposed project.

6.3.2.2 Groundwater

Aquifer Recharge

The construction of drainage features, the use of infiltration ponds, and site reclamation have the potential to change the distribution of aquifer recharge across the Upper Site. If this recharge pattern is disturbed, it may impact the flow of water in upland streams and springs on the flanks of Grouse Ridge. The overall goal should be to manage stormwater runoff during site development and reclamation to maintain the natural pattern of recharge. The following actions are proposed to mitigate potential impacts:

- Infiltration ponds should be located over areas where the continuous shallow and/or deep perching layers are present and in proximity to the springs so that infiltrating water has the potential to discharge to the springs.
- Infiltration ponds should be located as close as possible to the area where the stormwater is collected. It is recommended that at a minimum, each 50-acre area that is mined should have its own infiltration pond.

- Maintenance, such as periodic removal of fine-grained sediments, should be performed as needed to optimize pond function. This maintenance should be included as part of the drainage design and operations and maintenance plan.
- To prevent surface water runoff from flowing out of each 50-acre area, berms should be maintained around the perimeter of each area.

Groundwater Quality

The following action is proposed to mitigate potential groundwater quality impacts:

- To maintain groundwater quality and minimize potential introduction of turbid water into groundwater beneath the Lower and Upper Sites, stormwater infiltration ponds should be designed in accordance with the *King County Surface Water Design Manual* to filter out suspended silt and clay.

Buffer Zone

Lower Site. To maintain an adequate buffer zone between the base of the excavation and underlying aquifers at the Lower Site, the following mitigation measures are proposed:

- Excavation in the easternmost portion of the Lower Site should be limited to periods when it can be reasonably demonstrated, based on the water levels in the existing wells, that a buffer zone of at least 10 feet is present.
- A groundwater interception trench should be constructed or installed to maintain a minimum buffer zone during site operations. Regular inspections and maintenance should be performed to ensure that the groundwater interception trench is functioning properly.
- A shallow piezometer should be installed adjacent to the groundwater interception trench and monitored periodically during the winter and early spring to confirm that the trench is maintaining a minimum 5-foot buffer zone.
- In the event that the interception trench does not maintain an adequate buffer zone, active dewatering (i.e., pumping) should be required. Groundwater removed by the interception trench and/or pumping would be transferred into the infiltration pond, where it would be returned to the groundwater system. If a 5-foot buffer zone cannot be maintained, operations should cease and mobile equipment should be removed from any portion of the mine pit without a sufficient buffer zone.

Upper Site. To maintain a buffer zone at the Upper Site and mitigate potential impacts to water quality, the following actions are proposed:

- Avoid excavation in areas where groundwater associated with the continuous shallow and deep perching layers is within 5 feet of the base of the excavation.

- Cease excavation in areas where the water table of the continuous perching layers is encountered above an elevation of 1,540 feet above msl. Excavation could continue in these areas if the water level declines sufficiently to maintain a 5-foot buffer zone and measures are taken, such as berming, to prevent flow of water into other areas of the excavation and to prevent the introduction of contaminants into the seasonally exposed perched groundwater.

Groundwater Monitoring

Lower Site. The following groundwater monitoring activities are proposed to confirm that the mitigation measures designed to protect groundwater quality are effective and to confirm hydrogeologic conditions beneath the Lower Site:

- Water level data from the existing onsite wells, the well proposed in the area northwest of the processing area, and Sallal Well No. 3 should be collected at regular intervals to confirm the direction of groundwater flow beneath the western portion of the Lower Site.
- Based on the groundwater flow direction confirmed through the measurements recommended above, an additional monitoring well or wells should be installed downgradient of the processing area in the event that the well proposed in the northwest portion of the site is not located downgradient.
- A groundwater quality monitoring plan should be implemented to assess potential impacts to groundwater quality. Minimum plan design should determine critical data elements, data collection techniques, frequency of monitoring, parameters for analysis, data reporting, location of monitoring stations, depth of monitoring well(s), independence of data gathering, interpretation of data, measurement and determination of direct impact to either buffer zone or to nearby wells from operations, required operator response to direct observable impact in either regard, and any other information or data necessary to comply with federal, state and local regulations and mitigation conditions necessary to prevent significant environmental impact. The program should include at a minimum baseline sampling and analysis, prior to construction, to provide data for comparison with future monitoring results. Following construction, the frequency of monitoring should consider the proximity of the nearest receptors (such as downgradient wells), the estimated groundwater velocity, and the anticipated response time for any corrective action that may be required in the event that groundwater quality is affected. Groundwater samples should be analyzed for metals, turbidity and pH, and any other parameters that would be required by the grading permit and other applicable permits.

Upper Site. To provide the data needed to maintain a buffer zone at the Upper Site, the following actions are proposed:

- Collect additional baseline water level data during the winter and spring using the existing monitoring wells on the Upper Site to further

assess the potential areas where the groundwater on the continuous shallow perching layer may intercept the base of the planned excavation.

- Maintain the wells installed above the continuous shallow perching layer during the excavation, and monitor the water levels in these wells.

If Cadman, Inc. proposes to excavate deeper than an elevation of 1,535 feet above msl, further evaluation of the hydrogeologic information collected at the Upper Site should be required. It is expected that excavating deeper could have a significant impact on the springs and upper reaches of the streams that originate on Grouse Ridge if the silty layers that appear to perch groundwater below an elevation of 1,535 feet above msl are breached. This option to excavate beyond an elevation of 1535, if selected by Cadman, Inc., would require a Supplemental EIS, including appropriate mitigation for groundwater and surface water impacts that could arise from excavating to a greater depth. This assessment could be performed in conjunction with King County's 5-year project review.

Spring and Surface Water Monitoring

To provide baseline data and assess potential impacts to springs and surface water on the Upper Site, the following actions are proposed:

- Collect additional periodic data regarding flow rates in the springs and streams around the perimeter of Grouse Ridge before excavation begins on the Upper Site to provide a baseline against which post-excavation stream gauging data can be compared.
- Baseline water quality data from a limited number of springs on the north and south sides of the ridge should be collected to document existing conditions. The analytes should include turbidity, as well as those required by the grading permit and other applicable permits. The turbidity of the surface water should also be measured.
- When the proposed gravel operation is active on the Upper Site, regular observations and measurements of stream flow should be performed to confirm that impacts are not significant. Water quality testing should not be necessary unless the impacts to the water are visually evident (for example, the water appears turbid) or as required by the grading permit or other applicable permits.

6.3.2.3 Water Supply

The following action is proposed to mitigate the potential impacts associated with the use of groundwater at the Lower Site:

- The water supply well should be located in an area of the property and screened at a depth where it can be shown that there would be no significant interference with the water levels in nearby water supply wells due to the pumping of groundwater at the Lower Site.

- If pumping impacts are predicted or observed based on the test pumping of the proposed well, Ecology has the jurisdiction to either deny the right, or to approve the right with limitations or mitigation requirements. Ecology has indicated that minimum instream flow requirements are seasonally not met on the Middle and South Forks of the Snoqualmie Rivers, and although the basin is not closed to new water rights, further appropriation of waters from the basin would require mitigation such as the transfer or retirement of existing rights.
- A contingency water supply plan should be prepared to provide a high quality water supply to the Sallal Water Association (e.g., a new well or water treatment). The plan could then be implemented if impacts from the gravel operation were detected at Sallal Well No. 3.

6.3.3 Alternative 3—Lower and Upper Sites Mining (Including Limited Lower Site Mining)

6.3.3.1 Surface Water and Water Supply

The mitigation measures for surface water and water supply described under Alternative 2 would also apply to Alternative 3.

6.3.3.2 Groundwater

The mitigation measures for groundwater described under Alternative 2 would also apply to Alternative 3. In addition, the following mitigation measures are proposed:

- A more detailed groundwater investigation should be performed on the portion of the Upper Site that would be used for sand and gravel processing, because this would be permanent facility and seasonal high groundwater cannot be easily avoided by working in other areas.
- A buffer zone of 10 feet above the seasonal high water table should be maintained in this area to account for potential water table fluctuation. If an interception trench were installed, the buffer zone could be decreased to 5 feet.

6.3.4 Alternative 4—Upper Site Mining - Exit 38

6.3.4.1 Surface Water and Water Supply

The mitigation measures for surface water and water supply described under Alternative 2 would also apply to Alternative 4.

6.3.4.2 Groundwater

No mitigation would be required for the Lower Site under this alternative because it would not be mined. The mitigation measures for groundwater at the Upper Site described under Alternative 3 would also apply to Alternative 4.

6.4 Significant Unavoidable Adverse Impacts

The project would be unlikely to have significant and unavoidable adverse impacts on water if the proposed mitigation measures described above were to be applied.